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An Analysis of U.S. Army Fratricide Incidents during the Global War on Terror (11 September 2001 to 31 March 2008)

By Catherine M. Webb
Kate J. Hewett

United States Army Aeromedical Research Laboratory
Warfighter Performance and Health Division

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Catherine M. Webb
Kate J. Hewett

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Aeromedical Research Laboratory
P.O. Box 620577
Fort Rucker, AL 36362

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14. ABSTRACT
Fratricide is a harsh reality during combat operations. Over the course of 2004-2007, the number of fratricide incidents per year increased, and experts speculate this is due to the high operational tempo and the reliance on technology during the current war. The objective of the present study was to classify the causes of U.S. Army fratricide incidents using the well known Human Factors Analysis and Classification System (HFACS) and the recently developed Fratricide Causal Analysis Schema (FCAS) to determine the leading causes of U.S. Army fratricide incidents and to provide recommendations for potential countermeasures. The FCAS and HFACS analysis revealed that many of the causal factors of U. S. fratricide incidents were related to human error (e.g., leadership, judgment and decision making, and emotional states). In addition to a need for more objective risk assessments, improved supervision and leadership may have the greatest potential to reduce U.S. Army fratricide incidents.

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Introduction

Fratricide has been defined as “the employment of friendly weapons and munitions with the intent to kill the enemy or destroy his equipment or facilities, which results in unforeseen and unintentional death or injury to friendly personnel” (Department of the Army, 1992). Some argue this definition is restrictive and does not take into account deaths due to accidental explosions, misfires, or training accidents (Steinweg, 1995). As a result, the true rate of fratricide is usually higher than what is reported.

Detailed reports of fratricide can be found in nearly all major wars, even dating as far back as the French and Indian War in 1758 (Doton, 1996). Historical fratricide rates are presented in table 1. However, the problem of fratricide only began receiving great attention after Operation DESERT STORM, the first war to be fought with modern weapons and technology. More recently, two fratricide incidents have been widely publicized: the Tarnak Farms incident in 2002 involved the accidental killing of four Canadian soldiers by a U.S. F-16 (Halbfinger, 2003), and the controversial death of CPL Pat Tillman in 2004 (Nichols, 2006). Needless to say, fratricide is not a new problem of war.

Table 1.
Historical Fratricide Data (Steinweg, 1995).*

Conflict	Source of Data	Fratricide Rate
World War I	Besecker Diary (Europe)	10% Wounded in Action (WIA)
World War II	Hopkins, New Georgia	14% Total Casualties
	Burma	14% Total Casualties
	Bougainville Study	12% WIA
		16% Killed in Action (KIA)
Korea	25th Infantry Division	7% Casualties
Vietnam	WEDMET (autopsy)	14% KIA (rifle)
	WEDMET (autopsy)	11% KIA (fragments)
	WEDMET	11% Casualties
	Hawkins	14% Casualties
JUST CAUSE	U.S. Department of Defense	5-12% WIA
		13% KIA
DESERT STORM	U.S. Department of Defense	15% WIA
		24% KIA

*Detailed references for historical fratricide data can be retrieved from Steinweg (1995)

Most fratricide incidents are due to multiple contributing factors. Common causes of combat identification errors include “inadequate training, poor leadership, inappropriate procedures, language barriers, and an inability to communicate changing plans” (Wilson, Salas, Priest, & Andrews, 2007).

Beyond the tragic loss of manpower, fratricide incidents also have a negative effect on the unit, including loss of confidence, disrupted operations, loss of aggressiveness, and overall decrease in morale (Department of the Army, 1992). Soldiers may begin to second guess the intelligence information they receive or over-analyze situations, and leaders may develop overly

complex rules of engagement (ROE), which all can slow the tempo of the operation. Fratricide incidents also have a financial cost, including expensive accident investigations and loss of equipment (Hart, 2005).

Fratricide countermeasures currently in use include the Ground Soldier System and the Joint Combat Identification Marking System (Del Stewart (Requirements Integration Directorate ARCIC, TRADOC), Personal communication, 21 May 2010). The Joint Combat Identification Marking System consists of combat identification panels (CIP), thermal identification panels (TIP), and infrared beacons (Rose, 2009). Both the CIP and TIP are covered with a thermal film that is designed to reflect radiated heat, producing a "cold spot" when viewed through thermal sights. The CIPs are used mainly for ground-to-ground identification, while the TIPs provide mainly air-to-ground identification. The infrared beacons are blinking strobes visible through night vision devices. Currently under development is the Ground Soldier System Increment I Nett Warrior, which will allow ground soldiers to see "their location, the location of fellow soldiers, as well as the location of known enemies on a moving map" (Lopez, 2010). The system is scheduled to be fielded around 2013.

Accident classification systems

The U.S. Army Combat Readiness/Safety Center (CRC) receives information Army-wide on all accidents, including fratricide. During a fratricide accident investigation, information is gathered from witness statements, radio logs, weather reports, reenactments, etc., and contributing factors are thoroughly analyzed by trained safety investigators. Findings are labeled as *present and contributing*, *present and suspected contributing*, or *present but not contributing (*Department of the Army, 2009*)*. Common findings include, but are not limited to, standards failures, fatigue, training failures, and environmental issues. For example, a final report may read:

> *Finding 1 Present and Contributing: Human Error – Leader Failure*
> *Finding 2 Present but not Contributing: Fatigue*
> *Finding 3 Present and Suspected Contributing: Human Error – Support Failure*

Recommendations are also provided by accident investigators with the intention of preventing such incidents from occurring in the future.

After an accident investigation is closed and official findings and recommendations are presented, the CRC then classifies all accidents, including fratricide, using the well known and very detailed Human Factors Analysis and Classification System (HFACS). Developed by Shappell and Wiegmann (2000), HFACS was developed to improve aviation accident investigations in the military. It describes 19 causal categories within four levels of failure: 1) "Unsafe Acts," 2) "Preconditions for Unsafe Acts," 3) "Unsafe Supervision," and 4) "Organizational Influences." An overview of the HFACS model can be found in appendix A. Each of the 19 causal categories are comprised of nano codes. For example, at the "Unsafe Supervision" level, the category *failure to correct known problem* is comprised of two nano codes, namely *personnel management* and *operations management*. A total of 147 nano codes

are present. The HFACS model is based on Reason's "Swiss cheese" model of human error (1990). Figure 1 describes how an accident is likely to occur when all of the errors, or "holes," align. A detailed description of HFACS can be found in Wiegmann and Shappell (2003).

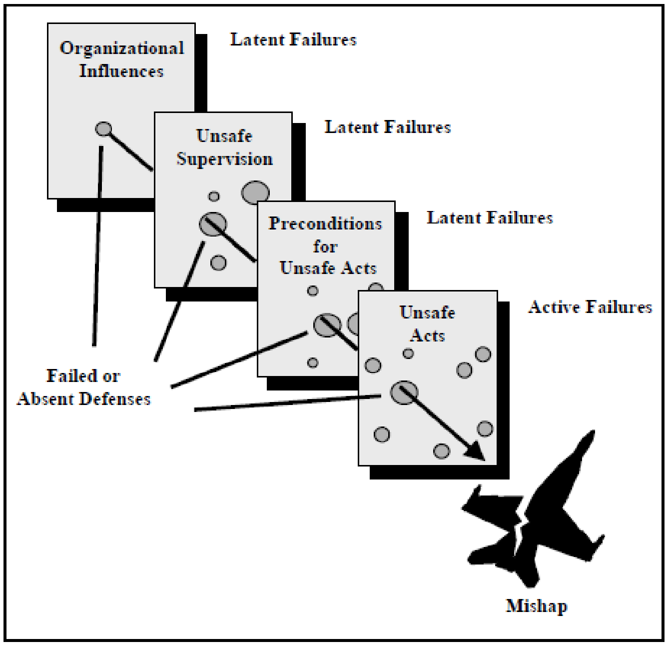

Figure 1. The Swiss cheese model of human error causation (Shappell & Wiegmann, 2000).

Recently, researchers from the United Kingdom (U.K.) developed the Fratricide Causal Analysis Schema (FCAS) designed specifically to analyze only fratricide accidents (Gadsden & Outteridge, 2006), unlike HFACS which is used to classify a broad range of accidents. The FCAS was the result of 6 years of research on the specific human factors issues involved in fratricide. An important assumption of the FCAS is that "fratricide incidents rarely are the direct result of a poor decision made at the point of fire," meaning each incident has a number of underlying causes, or issues. It allows for the identification of key issues, as well as contributing factors, for each fratricide incident.

The FCAS is comprised of 12 high level causal categories such as "Procedures," "Cognitive Factors," and "Misidentification." The 12 categories contain a number of more specific sub-categories (see appendix B for complete schema). For example, *fatigue, stress, anxiety, confusion, fear*, and *arousal* are grouped together under the high level category of "Physical/Physiological." A total of 57 sub-categories are present. More detailed information about each of the categories can be found in Outteridge, Blendell, Molloy, and Pascual (2006).

Using the FCAS, Gadsen and Outteridge (2006) analyzed 10 U.K. fratricide incidents that occurred during 1991-2003, specifically from Operation GRANBY (U. S. Operation Desert Storm), Operation PROVIDE COMFORT (humanitarian aid in northern Iraq), and Operation

TELIC (U.S. Operation Iraqi Freedom). These accidents were selected because of the detail of the information collected. During the analysis, frequency data were collected regarding the number of issues that appeared under each of the 12 high level factors. For example, after reviewing the 10 incidents, there were 15 issues specific to "Teamwork" (figure 2). The categories with the highest number of issues were "Communication," "Procedures," "Command and Control," and "Misidentification." This analysis identified the common causes of fratricide and provided recommendations to reduce fratricide.

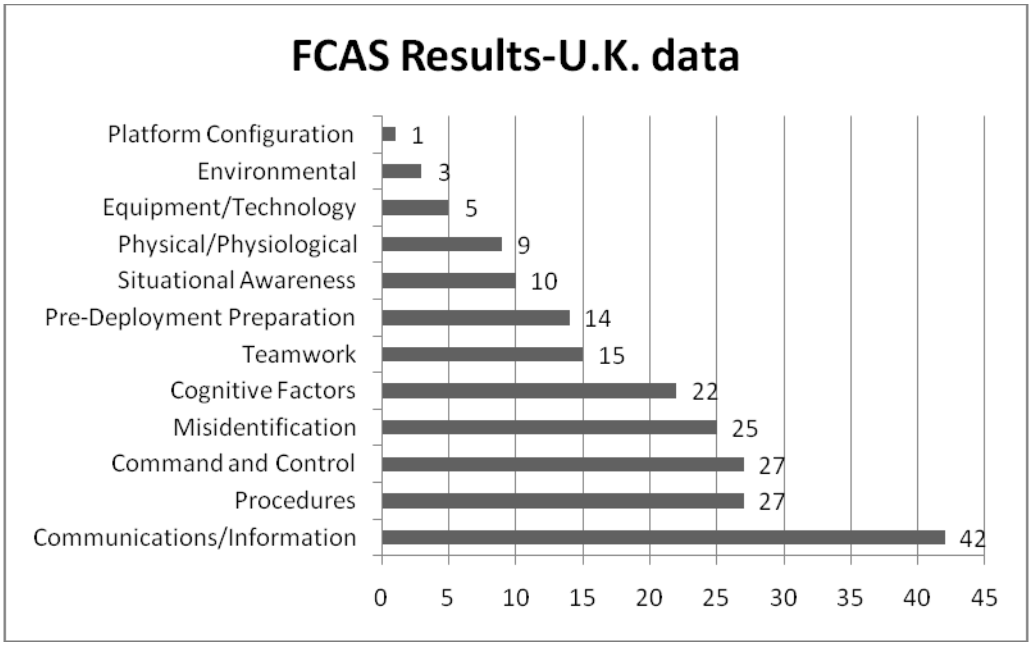

Figure 2. Results for the classification of 10 U.K. fratricide incidents using the FCAS (Gadsden & Outteridge, 2006).

Military relevance

Unfortunately, fratricide is a harsh reality in combat operations. According to data from the CRC, there were 55 U.S. Army fratricide incidents from 11 September 2001 to 30 March 2008. Forty of these were Class A* accidents, resulting in the deaths of 30 U.S. Army personnel. Over the course of 2004-2007, the number of fratricides per year increased; experts speculate this increase is due to the high operational tempo and the reliance on technology during the Global War on Terror (Hart, 2005). As today's military fights alongside various allies, the issue of combat identification is receiving increased research attention. Though there are claims fratricide will always be a part of war and that no amount of technology will succeed in eliminating it (Hart; Doton, 1996), by classifying the factors that contributed to recent fratricide incidents,

* Damage costs of $2,000,000 or more and/or destruction of an Army aircraft, missile or spacecraft and/or fatality or permanent total disability

countermeasures can be developed and applied to in-theater operations which will hopefully reduce the number of fratricide incidents.

Research objectives

The objective of the present study was to classify the causes of U.S. Army fratricide incidents from 11 September 2001 to 31 March 2008 using the HFACS and the FCAS to determine the leading causes of U.S. Army fratricide incidents, and provide recommendations for potential countermeasures.

Methods

Accident reports from Class A U.S. Army fratricide incidents from 11 September 2001 to 31 March 2008 were reviewed. The accident reports were provided by the CRC at Fort Rucker, AL. Unclassified descriptive data (e.g., year of accident, location of accident, number of fatalities per accident) were extracted from the Army Risk Management Information System (RMIS) Quick Search.

The first phase of the analysis classified the U.S. Army fratricide incidents using the HFACS. Only those findings considered *present and contributing* were coded in HFACS. The findings from the accidents were coded with version 6.02 nano codes by HFACS analysts at the CRC.

The second phase of the analysis classified the same set of U.S. Army fratricide incidents using the FCAS. Two research psychologists with a background in human factors used the FCAS to classify the findings previously identified by the accident review board. Only findings considered *present and contributing* were classified with the FCAS. The authors referred to Outteridege, Blendell, Molloy and Pascual (2006) for guidance using the FCAS.

Results

During the time period under consideration, 40 U.S. Army Class A fratricide incidents, both aviation and ground, occurred. All incidents resulted in the death of a U.S. Army Soldier and/or ally. Figures 3 and 4 present descriptive details from the 40 fratricide accidents.

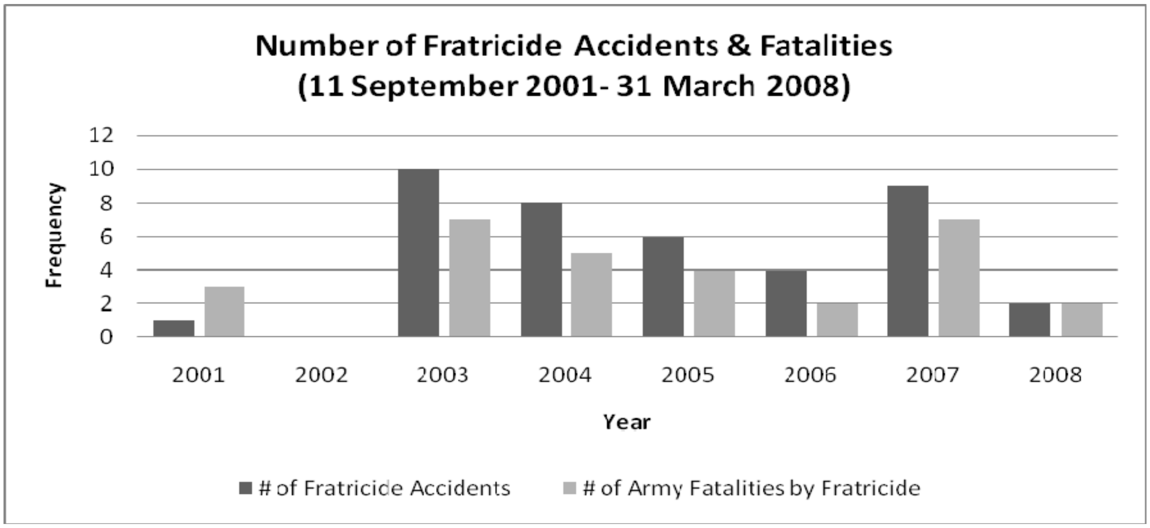

Figure 3. Number of fratricide accidents and fatalities by year (observed frequency (f_o) = 40). Note that Year refers to calendar years.

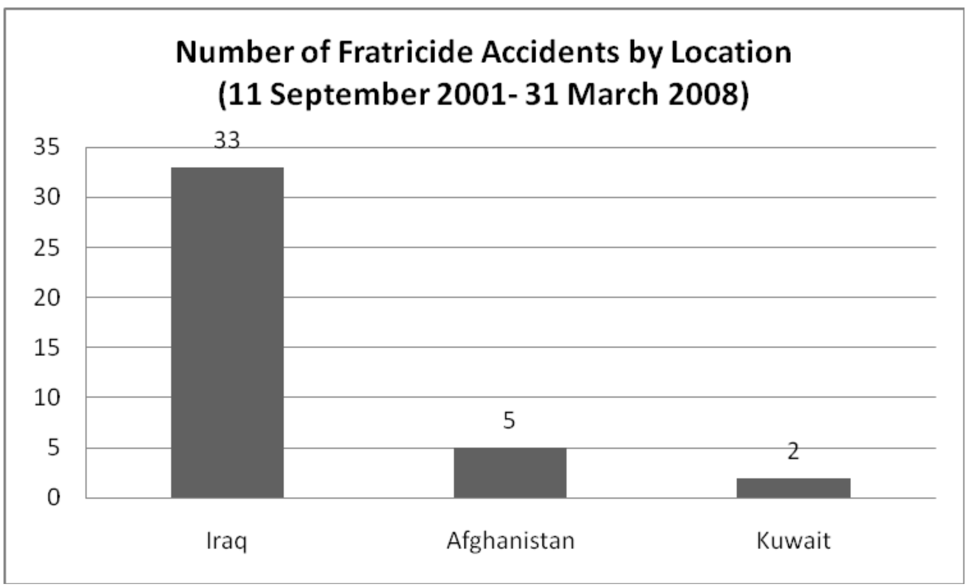

Figure 4. Number of fratricide accidents by location (f_o = 40).

Of the 40 Class A U.S. Army fratricide accidents, 17 were excluded from analysis due to insufficient information. In some cases there was only an abbreviated accident report, others involved investigations closed by the CRC due to lack of information, and a few cases contained only an initial report of the accident. In addition, three accidents were excluded from analysis as they were deemed “no fault” by the accident investigation board. Therefore, a total of 20 were analyzed. Descriptive statistics for the 20 accidents included in the analysis are presented in figures 5 and 6. These 20 accidents, all ground accidents, resulted in the deaths of 16 U.S. Army personnel.

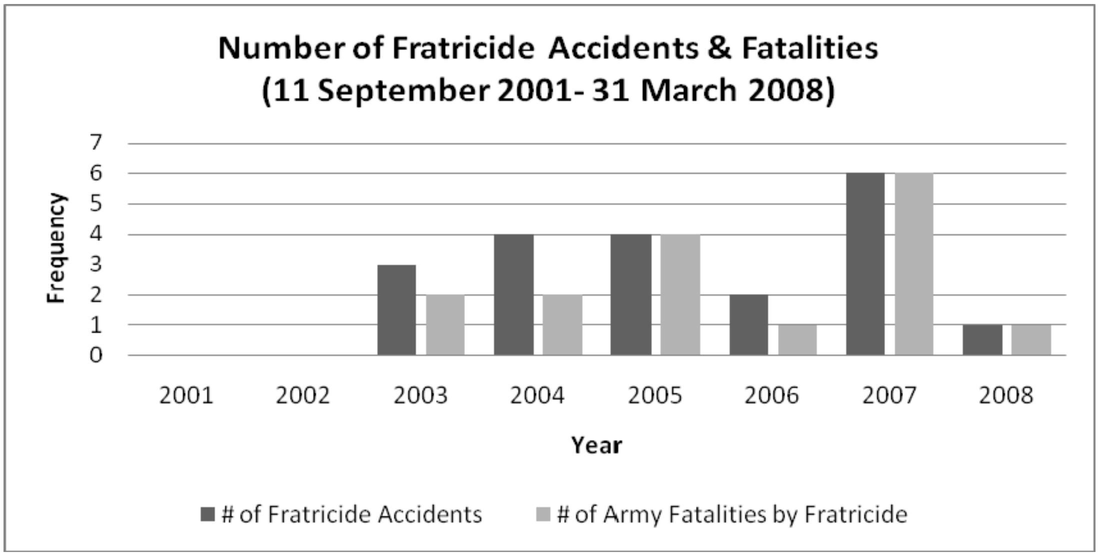

Figure 5. Number of fratricide accidents and fatalites by year (f_o = 20). Note that Year refers to calendar years.

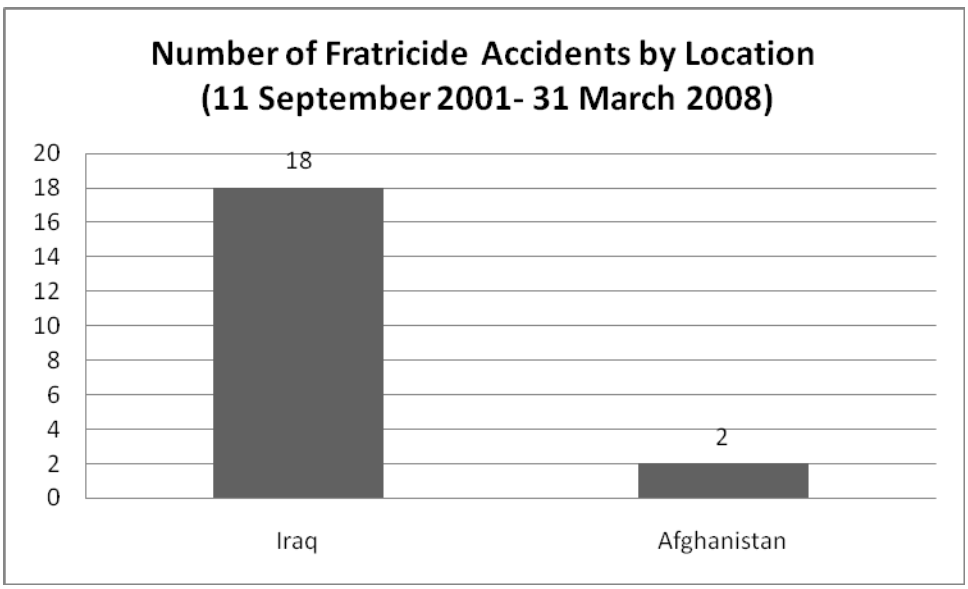

Figure 6. Number of fratricide accidents by location (f_o = 20).

HFACS analysis

Recall that HFACS organizes its findings by four levels of failure. Figures 7 through 9 present frequency data with regard to errors related to “Unsafe Acts,” “Preconditions for Unsafe Acts,” and “Unsafe Supervision.” Three findings were attributable to “Organizational Influences”: *operational tempo/workload*, *personnel resources*, and *acquisition policies/design process*.

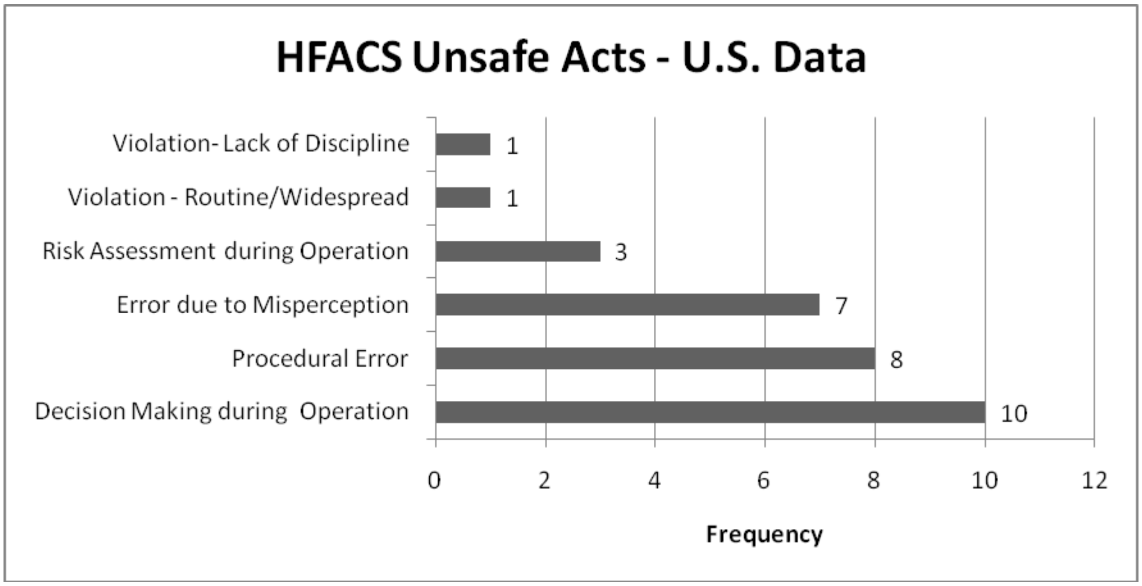

Figure 7. Results from HFACS classification of 20 U.S. Army fratricide accidents ("Unsafe Acts" only).

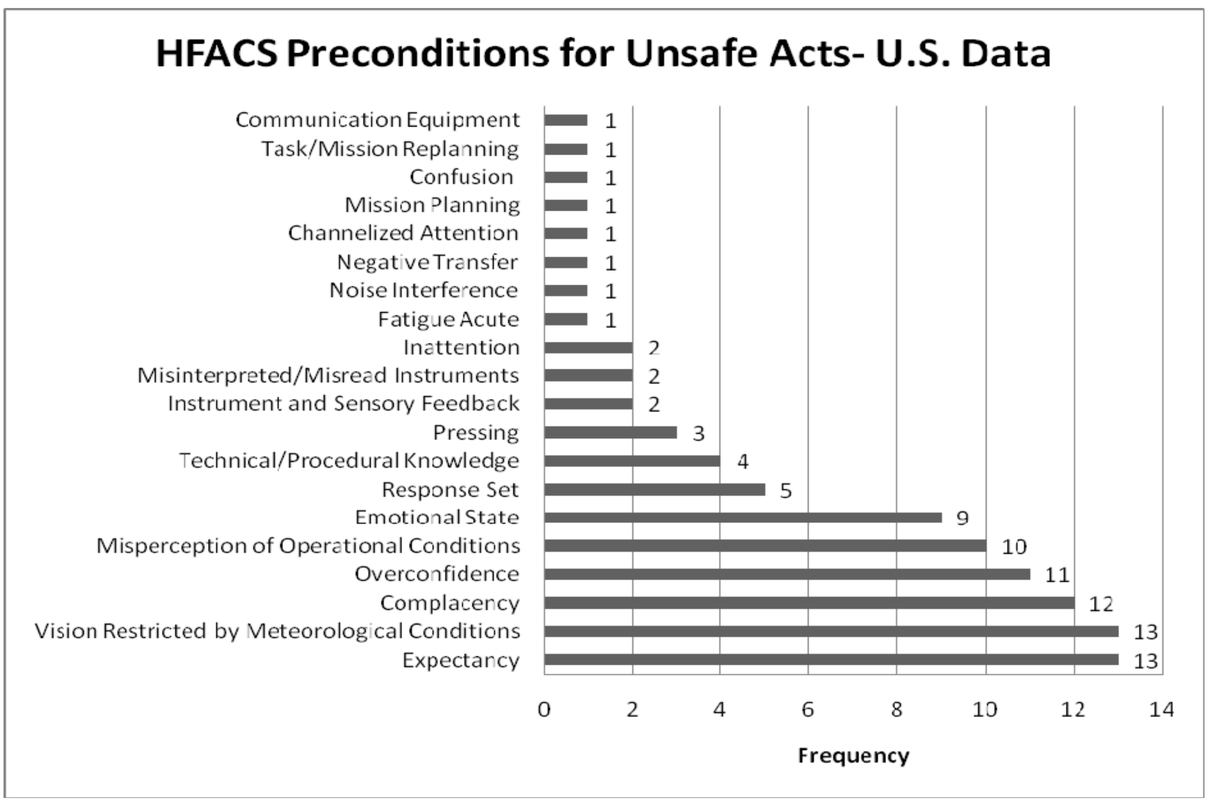

Figure 8. Results from HFACS classification of 20 U.S. Army fratricide accidents ("Preconditions for Unsafe Acts" only).

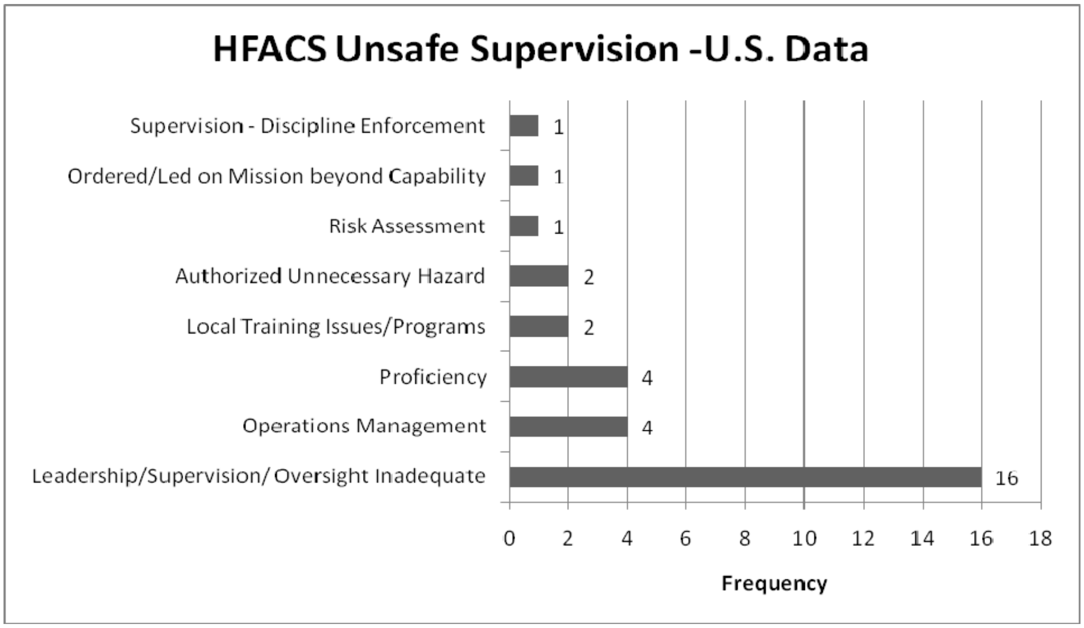

Figure 9. Results from HFACS classification of 20 U.S. Army fratricide accidents ("Unsafe Supervision" only).

Within HFACS' four levels of failure, most of the causal factors from the U.S. fratricide data were related to "Preconditions for Unsafe Acts." More specifically, the preconditions were related to *conditions of the individual* (e.g., cognitive, perceptual, and psycho-behavioral factors) rather than *environmental* or *personnel factors*. However, the nano code with the greatest number of occurrences was *inadequate leadership* at the "Unsafe Supervision" level. Other common findings include *expectancy, vision restricted by meteorological conditions*, and *complacency*, which were all "Preconditions for Unsafe Acts."

FCAS analysis

Figure 10 presents the results from the FCAS classification of U.S. fratricide data. From these data, the most common causes of U.S. fratricide accidents were related to the categories "Misidentification," "Teamwork," and "Procedures." Common findings related to "Misidentification" included *combat identification measures,* the *actions of the target*, and the *physical features of the target*. The majority of the findings under the "Teamwork" category were related to *leadership* issues, and most of the findings under the "Procedures" category involved *fire control and discipline*. In fact, the *leadership* sub-category had the greatest number of occurrences of all 57 sub-categories. A total of 98 findings were identified with the FCAS analysis (see appendix C for frequency data for specific FCAS categories). Other common causal factors include *confidence* and *training.*

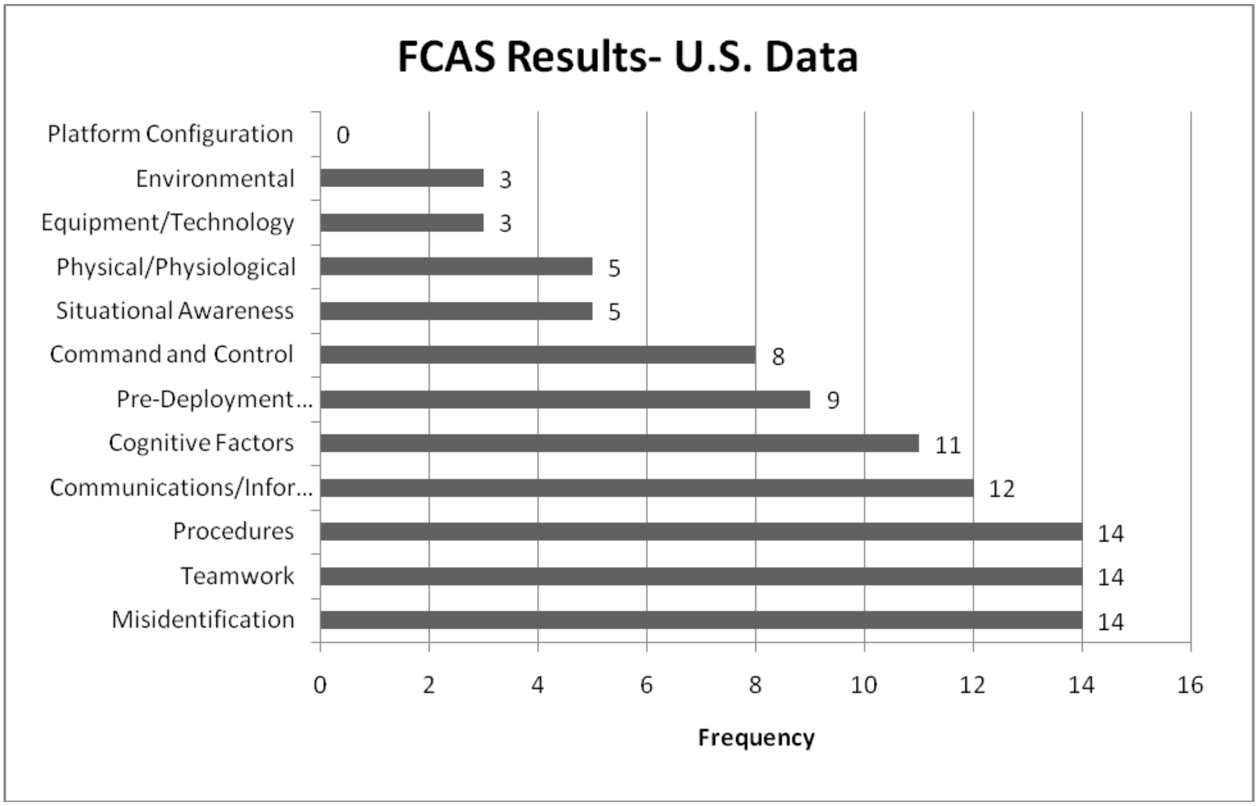

Figure 10. Results from the FCAS classification of 20 U.S. Army fratricide incidents.

Data from figure 10 were compared to the results of the Gadsden and Outteridge (2006) analysis from figure 2. The most common findings from the U.K. fratricide data were related to "Communications," "Procedures," and "Command and Control" issues. A total of 200 findings were identified in their analysis. With regard to the number of times causal factors related to "Communications" were identified, the difference between the U.K. (f_o = 42) and U.S. (f_o = 12) data was significant, as revealed by a Chi Square goodness of fit test ($X^2_1 = 16.67$; $p < 0.05$). The difference between the U.K. and U.S. data with regard to "Procedures" (f_o = 27, f_o = 14, respectively) was also significant ($X^2_1 = 4.12$; $p < 0.05$). In addition, there were significantly more findings related to "Command and Control" issues for the U.K. data (f_o = 27) than the U.S. data (f_o = 8) ($X^2_1 = 10.31$; $p < 0.05$).

Discussion

The results from our analysis of U.S. Army fratricide incidents using both the HFACS and FCAS indicated the most common causes of fratricide were non-technical in nature. A similar finding was found for the U.K. FCAS analysis of U.K. data (Gadsden & Outteridge, 2006). At first glance, it would seem that a solution to fratricide is to remove humans from the decision making process entirely. However, that is not possible for the current war. These findings support the claim that no amount of currently available technology will completely eliminate fratricide (Hart, 2005; Doton, 1996). As long as a human is still making the final decision to

engage a target, the possibility for making a mistake will still exist. In fact, some argue that advances in technology have exacerbated the fratricide problem (Doton). Experts and military leaders should stress the importance of training, education, and engaged leadership in preventing fratricide with technological countermeasures serving as a second line of defense. Accurate combat identification is the result of a combination of materiel and nonmateriel solutions, including training, doctrine, ROE, tactics, techniques and procedures (TTP), situation awareness, and cooperative and non-cooperative target identification capabilities (Del Stewart, Personal communication, 21 May 2010).

The most common causal factor related to U. S. Army fratricide incidents from the FCAS and HFACS analysis was related to leadership issues. Examples from actual cases include inexperienced leadership, leaders not conducting risk assessments, and leaders not sharing pertinent information with subordinates. The HFACS model highlights how adequate supervision can prevent an accident by providing an extra layer of defense. Leaders must assess the risk of fratricide in every mission and take steps to reduce those risks.

With regard to the HFACS analysis, "Unsafe Acts" are most closely tied to an accident, and they can be categorized as *errors* or *violations*. *Errors* are activities of the operator that fail to achieve their intended outcome while *violations* involve a willful disregard for the rules (Wiegmann & Shappell, 2001). Most of the "Unsafe Acts" related to the U.S. fratricide data were *errors*, not *violations*. Specifically, the errors were related to j*udgment and decision making*. It has been said that the battlefield is one of the most difficult places to perform a cognitive task (Wilson, Salas, Priest, & Andrews, 2007). Under stress, people often rely on general strategies, or heuristics, to make decisions rather than evaluating all available information. Common heuristics include representativeness (judging a sample as likely if it is similar to the population from which it was selected), availability (using the relative availability of examples to aid decision making), and anchoring (relying too heavily on initial assessments) (Tversky, & Kahneman, 1982). In addition, people are usually unaware of these flaws in their judgments. These limitations need to be taken into consideration when designing future systems to aid in combat identification, and the most informative cues need to be the most salient.

The present study identified the need for realistic and objective risk assessments due to the prevalence of complacency and overconfidence. In many cases, soldiers and leaders were overconfident in their abilities and were faulted for not double checking plans. Along the same lines, it was often found that information sharing was reduced due to overconfidence. Soldiers should be encouraged to share any bit of information to improve the team's overall situation awareness.

Issues related to pre-deployment preparation, specifically training, were also a common causal factor in U. S. Army fratricide incidents. Training issues were related to lack of training with equipment and navigation techniques. In addition, training regarding fire control and discipline was a common causal factor, in the form of soldiers violating rifle marksmanship basics. An additional casual factor that was present in the HFACS analysis was restricted vision due to meteorological conditions. Most often, soldiers were faulted for not using night vision devices (NVD) or using them incorrectly. It is important the soldiers are trained on the proper use of NVDs.

The present study identified common causal factors of U. S. Army Class A fratricide incidents. Additional information can be obtained from analysis of incidents resulting in less damage (Class B-F accidents) and even near-fratricide incidents. Other analyses of fratricide incidents stress the need to examine near-fratricide incidents as just as much information can be learned (Wilson, Salas, Priest, & Andrews, 2007; Gadsden & Outteridge, 2006). Leaders should encourage the reporting of such events.

While not the focus of the present study, a discussion of the two accident classification systems is warranted. One of the main points of discussion is the difference in specificity between the two systems. The FCAS contains 57 subcategories from which to classify, while the HFACS is comprised of 147 nano-codes. Although the HFACS allows for more specificity compared to the FCAS, some of the nano codes are germane only to the aviation domain, for which HFACS was originally created. For example, there are HFACS nano codes related to *inadequate anti-G straining maneuver*, *effects of G forces*, *hypoxia*, *trapped gas disorders*, etc. Although versions of HFACS have been created for use in domains such as air traffic control (HFACS-ATC) and medicine (HFACS-M.D.), a version specific to combat operations is not available. The FCAS, however, was developed specifically for fratricide accidents.

Limitations

Unfortunately, a great deal of the accident investigation process relies on subjective interpretations rather than objective evidence. The subjective nature of the accident classification process is a limitation of the present study. Although the researchers relied on the findings of the trained safety investigators for the FCAS analysis of the U.S. data, the causes were classified using the researchers' subjective judgment. In addition, a different set of investigators from the CRC performed the HFACS classification of the same set of fratricide accidents. Perhaps some differences between the FCAS and HFACS analysis of the U.S. data were due to the different individuals performing the classification, and not necessarily the differences between the two classification systems.

An additional limitation was the exclusion of 17 of the U.S. fratricide cases from the FCAS and HFACS analyses due to the unavailability of detailed accident investigations. Most of those cases were either old cases in which the CRC was unable to conduct a thorough accident investigation or more recent accidents with only initial accident reports. It should be noted that due to insufficient details, only 10 cases were included in Gadsden's and Outteridge's (2006) FCAS analysis of U.K. fratricide data. Retrospective analysis of fratricide incidents will be most powerful and relevant when all events, plus near-events, are available for careful study.

Conclusion

Historically, human error is a causal factor in approximately 80% of mishaps (Department of Defense, n.d.). The FCAS and HFACS analysis of U.S. fratricide data revealed that many of the causal factors were also related to human error (e.g., *leadership, judgment and decision making*, and emotional states like *complacency* and *overconfidence*). Therefore, human error must be considered in the design and development of fratricide countermeasures, including both technical

and human-centric solutions. In addition to a need for more objective risk assessments, improved supervision and leadership may have the greatest potential to reduce U.S. fratricide incidents.

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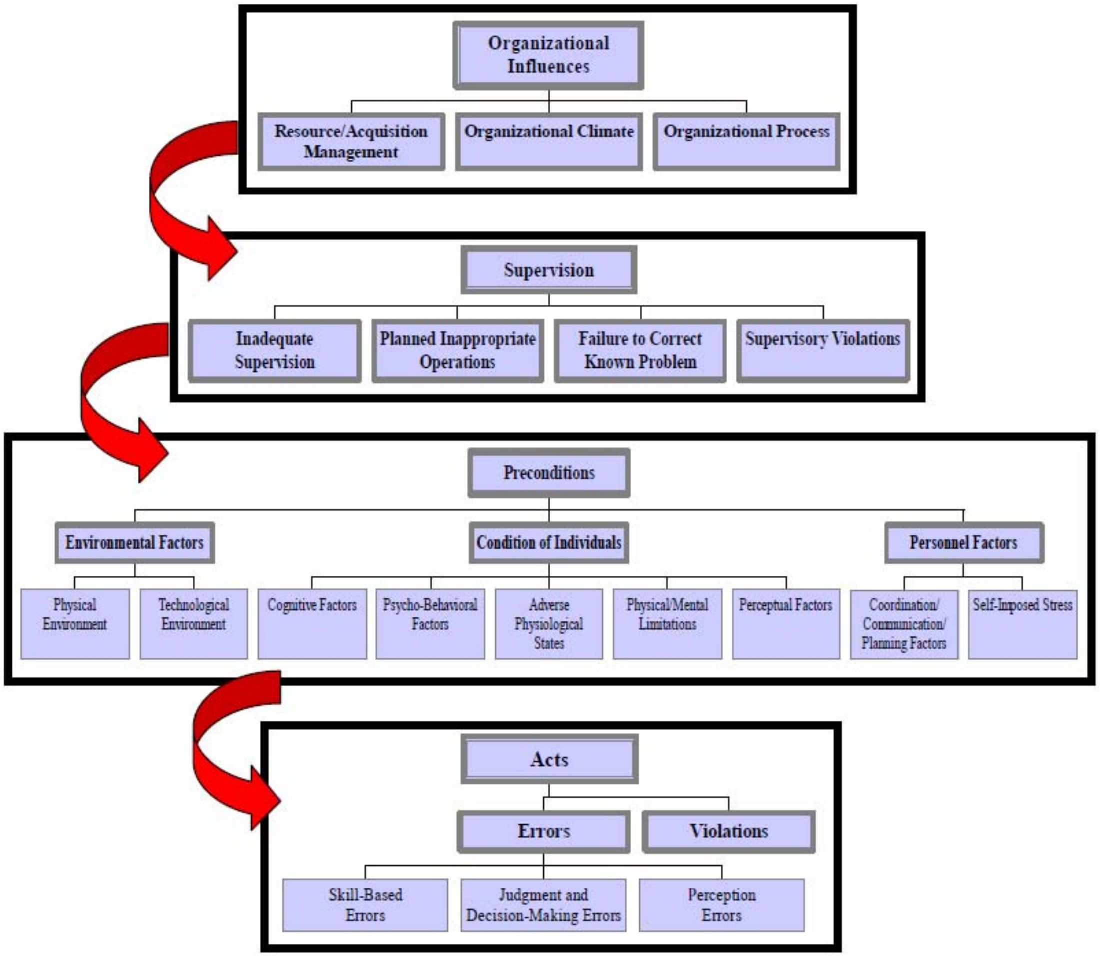
<u>Appendix A.</u>

Human Factors Analysis and Classification System (Department of Defense. n.d)



Appendix B.

Fratricide Casual Analysis Schema (adapted from Gadsden & Outteridge, 2006)

<table>
<tr>
<td>
<u>Command and Control</u>
Commander’s Intent
Orders
Briefing
Planning
Coordination
Disruption of Command and Control

<u>Procedures</u>
SOPs
ROE
Fire control and discipline
Doctrine
Navigation

<u>Equipment/Technology</u>
Equipment Failure
Weapons Handling Error
Weapons Misuse
Trust/Reliance on Technology
Communications Equipment
Technology misuse

<u>Situational Awareness</u>
Individual/Shared

<u>Misidentification</u>
Physical Features of Target
Target Recognition Training
Combat Identification Measures
Actions of Target
Restricted Vision

<u>Physical/Physiological</u>
Fatigue
Stress
Anxiety
Confusion
Fear
Arousal
</td>
<td>
<u>Pre-Deployment Preparation</u>
Rehearsals
Training

<u>Teamwork</u>
Teamwork Behaviors
Roles and Responsibilities
Degree of Distribution
Shared History
Leadership
Organizational Relationships

<u>Environmental</u>
Extreme Engagement Ranges
Weather Conditions
Terrain
Time of Day

<u>Communications/Information</u>
Information Presentation
Communication Procedures
Communication Failures
Language Barriers
Information Quantity
Information Gathering
Information Reliability
Information Sharing
Auditory Overload

<u>Platform Configuration</u>
Layout of Platforms

<u>Cognitive Factors</u>
Decision Making
Workload
Expectancy Bias
Attention
Risk Assessment
Confidence
</td>
</tr>
</table>

Appendix C.
FCAS frequency data

Command and Control-8 Commander's Intent Orders Briefing-1 Planning-5 Coordination-1 Disruption of Command and Control-1 **Procedures-14** SOPs-5 ROE Fire control and discipline-9 Doctrine Navigation **Equipment/Technology-3** Equipment Failure-1 Weapons Handling Error Weapons Misuse-1 Trust/Reliance on Technology Communications Equipment-1 Technology misuse **Situational Awareness-5** Individual/Shared-5 **Misidentification-14** Physical Features of Target-2 Target Recognition Training Combat Identification Measures-7 Actions of Target-3 Restricted Vision-2 **Physical/Physiological-5** Fatigue-2 Stress-1 Anxiety Confusion Fear Arousal-2	**Pre-Deployment Preparation-9** Rehearsals-1 Training-8 **Teamwork-14** Teamwork Behaviors Roles and Responsibilities-1 Degree of Distribution Shared History Leadership-13 Organizational Relationships **Environmental-3** Extreme Engagement Ranges Weather Conditions Terrain Time of Day-3 **Communications/Information-12** Information Presentation-1 Communication Procedures Communication Failures-6 Language Barriers Information Quantity Information Gathering Information Reliability-2 Information Sharing-1 Auditory Overload-2 **Platform Configuration-0** Layout of Platforms **Cognitive Factors-11** Decision Making Workload Expectancy Bias-1 Attention Risk Assessment-2 Confidence-8

Department of the Army
U.S. Army Aeromedical Research Laboratory
Fort Rucker, Alabama, 36362-0577
www.usaarl.army.mil

U.S. Army Medical Research and Materiel Command